# zMeasure user manual

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# *Introduction*

The proposed zMeasure software pack is intended to perform measurements of linear dimensions of objects that are inaccessible for manual measurement by some reasons. Only few objects base points with known 3D coordinates and a couple of pictures that are undistorted perspective projections of the measured object are needed to obtain results, commensurable with those of classic photogrammetry methods. By using the recognized projections of the base points on pictures, their calibration is performed.

The measuring itself is performed by picking the points on the projections. Each pick of a point on some of the projections gives information of a half point in 3D space. Practically the projection point defines a line in 3D space that goes thru the projection point and the view point. To define a 3D point, one more half-point in a form of additional geometrical place, where the point lays is needed. In zMeasure it can be another line, defined from projection of the same point, but on another picture, or some plane in the 3d space, defined from 3 known points, where the objects 3D point also lays.

In addition to measurements, zMeasure provides abilities to visualize the linear components of the 3D object on the registered pictures, and to create new projections of the object linear parts from the desired view point and orientation of the observer.

# *Usage of zMeasure*

Typically, the usage of the zMeasure includes four stages.

The first stage consists of preliminary preparation of the images. They should be taken with the maximal possible resolution and sharpens. As a rule, each digital camera suffers from a lens distortion. Since the measurements are very error sensitive, the distortion can, and leads to unacceptable results. This is the reason the image distortion correction module to be provided by zMeasure. Before usage, the images should be processed by it. This module works as a separate application and its description can be found in chapter "Working with ζiTransform".

The second stage is the project preparation. zMeasure expect the entire data – images, drawings and auxiliary files to be kept in separate folder for each project. Shearing the same folder for two or more projects is not allowed. So, to start a new project a new folder should be created. Then a new AutoCAD drawing should be started and saved in the project folder with appropriate name.

The object's 3D coordinate system should be positioned on a desired place and orientation in the drawing, the four base planar points or six base points in general position should be drawn relatively to the object coordinate system and connected with 3D polyline. It is possible more than one base points set to be used for different sets of pictures.

Then each of the pictures intended to be used, after straightening their straight lines by using ζiTransform software tool, should be saved in the project folder and inserted in the drawing. The base points should be recognized on the pictures and should be connected with a polyline in a same order like those of the 3D object.

The third stage consists of a registration of pictures and calibration their visual parameters.

# Using ζiTransform

Distortion correction may be handled with the provided **ζiTransform** software. It contains also Transform mode, used for perspective plane transformations, and Magic mode, used mainly for fun and entertainment.

For full reference and user guide, you can visit the **ζiTransform** User Manual, which can be found in installation folder of zMeasure.

## Image preparation

It can process raster images in most commonly used formats  *.bmp and  *.jpg. It is highly recommended bitmap file format to be used for saving if the intermediate results are concerned, because JPEG compression is performed with loosing the quality of the image.

After starting the **ζiTransform** you need to load picture file or paste image from Clipboard for processing, by using "File -> Load Image" or "Edit -> Paste" command from the main menu.

The right mouse button locks and unlocks the coordinates of the mouse pointer. When the coordinates are locked, a small mark appears on the corresponding point.

After loading the image you have to select the working mode by pressing one of the tabs on the Control Center at the bottom right corner of the main form. By default the undistort mode is selected after starting the software.

# Adjusting base lines
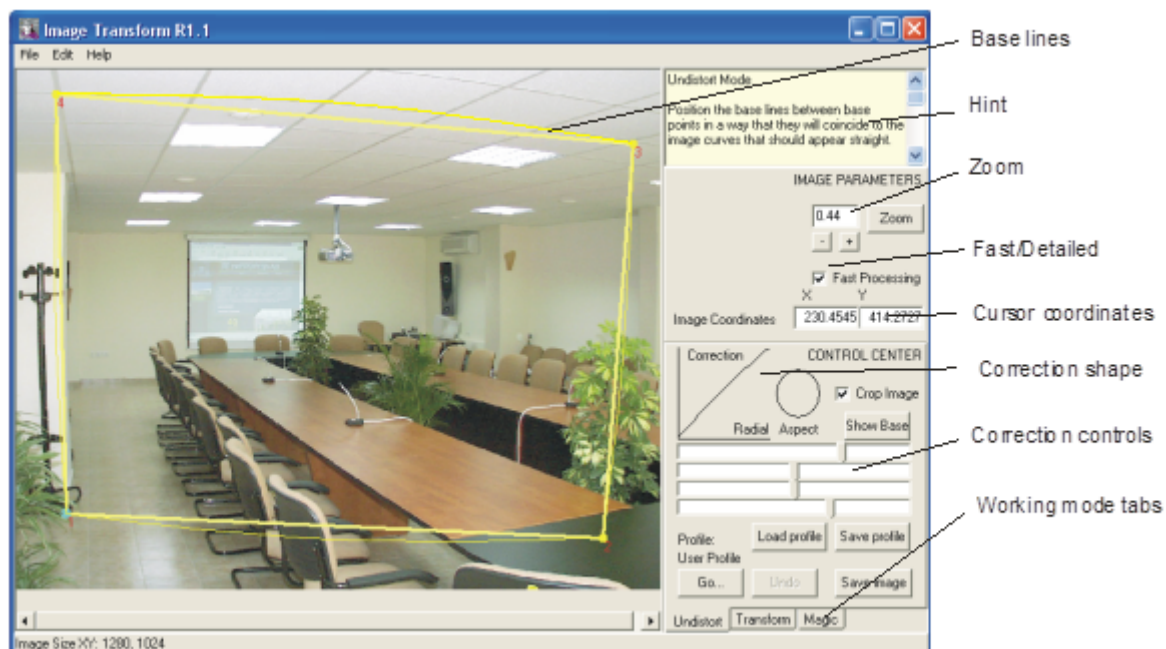


*Adjusting base lines in Undistort mode*

After source image is loaded and **Undistort** tab is selected, base rectangle appears over the image. You have to move each of its base points by mouse. This is done by placing the mouse pointer on the base point, then pressing the left mouse button and dragging the point to the desired location. For precise adjustment the point you can zoom and pan the image. You need to recognize two lines on the image that are curved, but are straight lines in reality on the source object. Once three base points or two pairs of base points are on their places, you can start to prepare the distortion correction.

The preparation of undistortion process requires adjusting the curvature of the base lines between base points in a way that they will coincide to the image curves that should appear straight. Use the four track bars in the **Undistort** tab sheet to adjust the curve. Note that the fourth track bar is intended to compensate the cylindrical optic of some digital camera lens. The cylindrical optic is intended because the CCD matrix where the object image is projected in most contemporary cameras are with square shape, and the typical image is rectangle with approximately 3/4 height/width ratio.

## Result and profiles



*Corrected image. Note the straight lines on the sealing panels.*

It is a good idea to calibrate your camera and to save its undistorting profiles. Then, when you process images taken in the same conditions, you can load the corresponding profile without losing time for new adjustment.

If the resulting image does not satisfies you, you can press **Undo** key, readjust the base lines and try again. Note that the undistort algorithm is very time consumable and even run on a temporary fast computers it can need few minutes for completion if the large images are processed. The bar on the bottom of the **ζiTransform** window shows the progress of the undistortion process.

After the completion of the undistortion process, you can save the results, or press Undo, or go forward by clicking one of the other tabs of the control center.

# zMeasure commands description

## Begin

⬚  `SM_BEGIN`

This command loads in to the current AutoCAD drawing edit session the calibration data, if any. The calibration data bends the pictures visual parameters to the known base points of the 3d model. If the calibration file is found and the number of registered pictures is two or more, their number is reported, else the prompt for calibration need is visualized. This is the first command that should be executed after after loading the zMeasure drawing.

## Calibrate 4 points

⬚  `SM_CAL4P`

This command adds correspondence between the3D model and a picture, representing it as a perspective projection. Four coplanar points on the 3D model and their projection points on the picture are used to calculate the external camera parameters – the placement and orientation of the camera in the 3D model space, focal distance, placement and orientation of the perspective projection. As a result two 3D polylines are drawn. The first one consist of the four vertices, the view point, center, X and Y axes of the project in 3D space. The second one represents the same points, but bounded to the projection's coordinate system. This command /or the command sm_cal6p, described below/ should be used for calibration and registration the all pictures, inserted in the drawing and intended to be used for measurement. Since collecting the necessary calibration data by picking point by point is a bit tricky, needs closed attention and is susceptible of errors occurrence, the preliminary data preparation is choose. That means that the four known points should be connected with two polylines in same order both in the 3D space and on the projection. The projection coordinate system also should be represent by polyline, connected the center, the middle of the right line and the middle of the upper line of the image frame. After starting the command, it expects the 3d polyline, then picture coordinate system polyline, and finally the picture known points polyline to be selected. After successful performing the necessary calculations, the calibration data is added to the calibration file.

## Calibrate 6 points

 SM_CAL6P

This command adds correspondence between the3D model and a picture, representing it as a perspective projection. Six no coplanar points in general position on the 3D model and their projection points on the picture are used to calculate the external camera parameters – the placement and orientation of the camera in the 3D model space, focal distance, placement and orientation of the perspective projection. As a result two 3D polylines are drawn. The first one consist of the four vertices, the view point, center, X and Y axes of the project in 3D space. The second one represents the same points, but bounded to the projection's coordinate system. This command /or the command sm_cal4p, described above/ should be used for calibration and registration the all pictures, inserted in the drawing and intended to be used for measurement. Since collecting the necessary calibration data by picking point by point is a bit tricky, needs closed attention and is susceptible of errors occurrence, the preliminary data preparation is choose. That means that the six known points should be connected with two polylines in same order both in the 3D space and on the projection. The projection coordinate system also should be represent by polyline, connected the center, the middle of the right line and the middle of the upper line of the image frame. After starting the command, it expects the 3d polyline, then picture coordinate system polyline, and finally the picture known points polyline to be selected. After successful performing the necessary calculations, the calibration data is added to the calibration file.

## Clear Calibration Set

 SM_CLEAR_ALL

This command deletes the entire calibration data, associated to the current project. It should be used in case of changes, made to the placement and scale of the pictures and the 3D model, or if some wrong calibration has been made. After executing the command a new calibration is needed.

## Draw 3D Polylines from Projection

 SM_DRAW3P

This is probably the most frequently used command of the zMeasure software pack.  By its help 3D polylines can be created vertex by vertex in 3D object space by using their pears of projections on the calibrated pictures. After starting the command, it checks if the calibration is performed. If it find calibration data, it prompts for a point. The point can be picked on each of the registered pictures. The picture that contains the point is determined automatically. After picking it, the temporary point mark is drawn on the projection, and temporary epipolar lines are drown on each of the remaining registered projections. Then the command prompts to pick the sane object point on some of the other projections. The point should lie on the epipolar line. After picking the point, the temporary point mark and epipolar lines are deleted, the 3D object coordinates of the point are calculated, and the temporary point marks are drawn both in 3D space and on the pictures. From the second vertex and on, the line segments are drawing as well. Then the following vertex is processed in a same way. The cycle lasts until exit or breaking the command.

## Define Drawn Plane

⬜ `SM_DEF_DWG_PLANE`

This command defines a plane in the 3D object space that serves as a geometric place of polylines created by using projection points. Before starting the command, a preparation is needed. The 3 object 3D points that define drawing plane should be connected with a 3D polyline. After executing the command, it prompts to select a polyline that contain the plane definition points. Before finishing, the projections of the polyline are drawn on the registered pictures. The plane definition is kept only in the current drawing session.

## Draw on plane

⬜ `SM_DRW_ON_PLN`

This command creates 3D polyline in the 3D object space, which vertices belong to the preliminary defined drawing plane. For defining a vertex, only one picking a point on some of registered pictures is needed. The command prompt for picking a point, and when the point is entered, the temporary point mark is drawn both in 3D model space and on registered pictures. From the second vertex and on, the line segments are drawing as well. Then the following vertex is processed in a same way. The cycle lasts until exit or breaking the command.

## Project all

⬜ `SM_PROJ_ALL`

This command projects the all selected objects linear elements – lines, polylines, circles, arcs, ellipses and splines – on the all registered pictures. The command is useful to examine the results if some of the object's elements are created or edited manually.

## Perspective

⬜ `SM_PERSP`

This command is similar to a camera that takes picture of the object from desired view point and along a desired direction, orientation and scale. Before usage the command, some preparations are needed. At firs a 3D polyline in the 3D object space should be drawn. Its first vertex should be placed in the desired view point, the second vertex should be in the center of the projective plane, and the third to lie on a plane, defined of previous two vertices and the X direction of the projection coordinate system. Then a rectangular frame with desired placement and size should be drawn in XOY plane of the world coordinate system. Finally the 2d polyline from the center, mid left edge and upper edge of the frame should be drawn. After starting the command, it prompts for 3 selection sets consequently. The first one should contain the first 3D polyline, the second one – the second 2D

polyline and the third one – the linear objects elements that should be projected. The third selection set should not contain the first 3D polyline since the projection of the view point is not defined.

## Installation

### Preparing your setup

- Ensure that your user name has Administrator permissions to install applications on the computer
- After installation, the usage and registration of products work well also without Administrator permissions
- You can obtain serial numbers for all products you want to install from http://cadbest.com/en/products.php. Otherwise you have the option for trial use for two weeks.

### Installation process

- Close all running applications and start your setup executable.
- Select next and read License Agreement. If you are agreeing choose "I accept the agreement".
- Choose which products you want to install.
- Select destination location. Choose a non-protected folder for the installation place of the product. The program Files folder is not suitable, especially if your OS is Windows 7. It is recommended that you use the default **c:\cadbestsoft** folder.
- Once you have installed the pack, your two-week trial period for evaluating the software starts.

## AutoCAD Integration

Since the SurfMaster (and zMeasure if you have installed it) are not stand alone applications, you'll have to plug them in a host application that maintains Autodesk® AutoLISP®. The host application can be AutoCAD® 2000 or later, IntelliCAD, or any other CAD software supporting lisp files.

After finishing installation process, you should load the provided menu files manually.

1. *Load the SurfMaster Menu following the steps below:*

- Start AutoCAD
- On the command line enter **MENULOAD** command
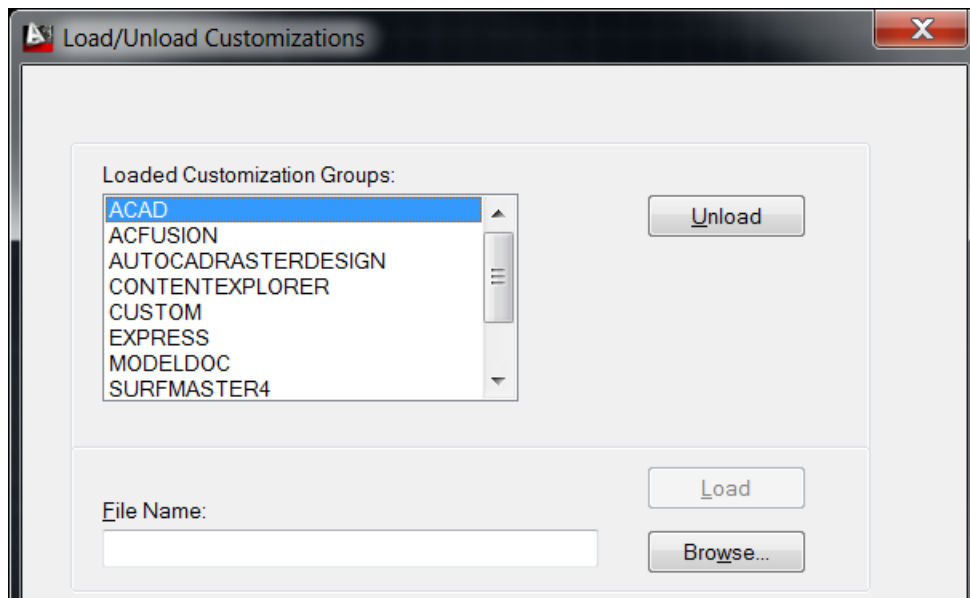
- ☐ Choose **Browse** button and select the **surfmaster.mnu** file from your installation folder and press the **Load** button.

- ☐ Repeat the steps for *zMeasure* if you have installed it (load the **zmeasure.mnu** file)

- ☐ Repeat the steps for *6Point Trilateration Positioner* if you have installed it (load trilpos.mnu file)

**2.** *Load the SurfMaster and / or zMeasure AutoLISP modules following the steps below:*
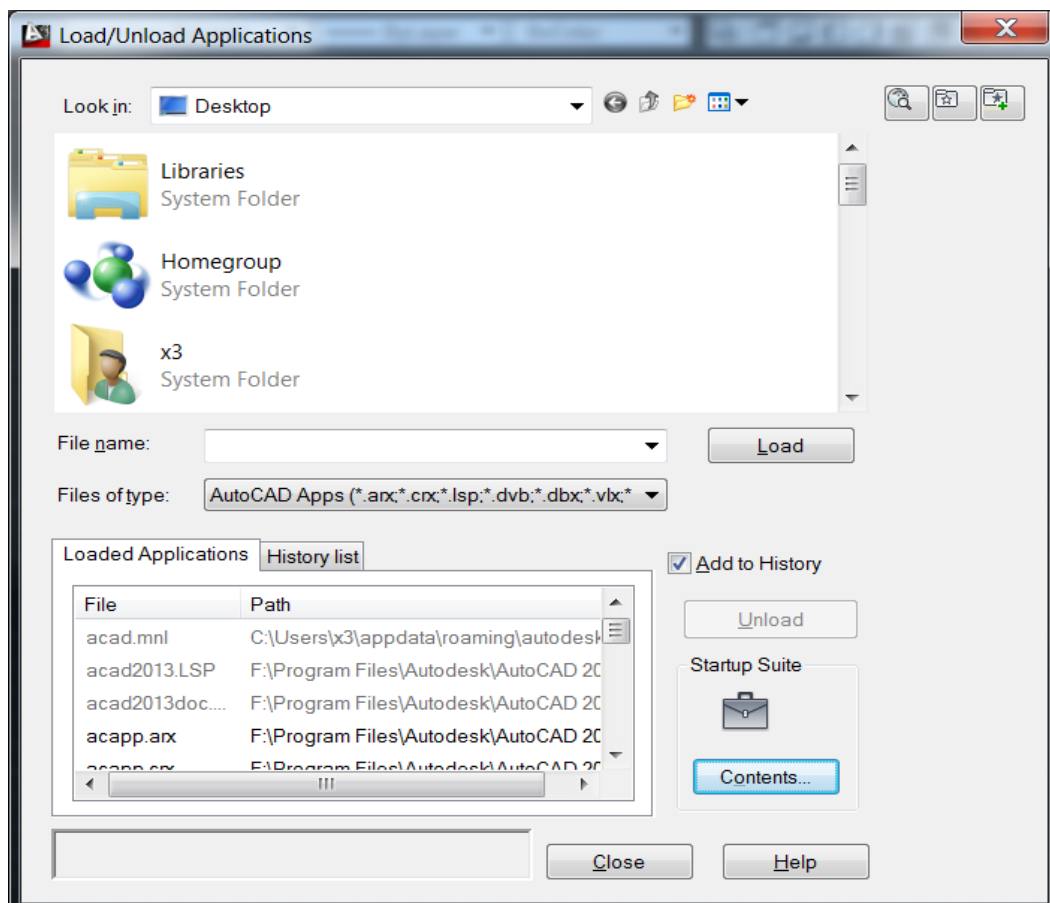
☐ From the **Main menu** select **Tools -> Load Applications (or use command "APPLOAD")**

☐ In the Load/Unload Applications dialog box navigate to **surfmaster4.lsp** file from your SurfMaster folder and press **Load** button. SurfMaster and all other AutoCAD applications that you have installed will be loaded in your current session.

☐ If you like SurfMaster (and zMeasure) to be loaded automatically each time when you start the host application, add the **surfmaster4.lsp** file in the **Startup Suite** (Contents**...** button) on the same dialog box.
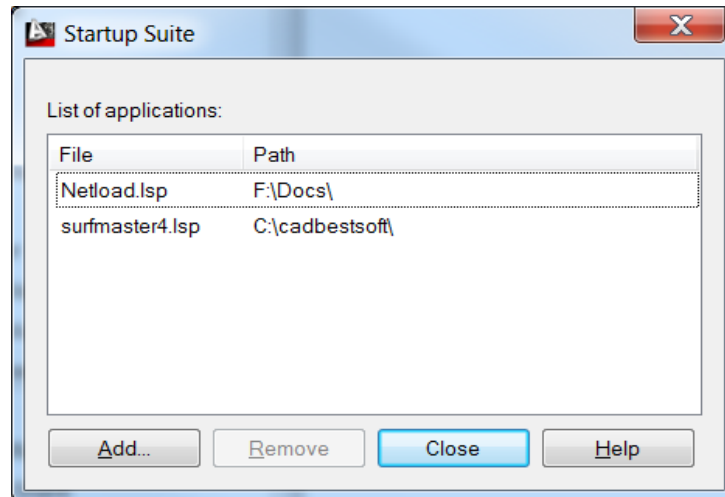


☐ There is no need to repeat the process for zMeasure or Trilateration 6Point Positioner, because they are already included in **surfmaster4.lsp** automatically.

### 3. *AutoCAD 2014*

Note, that if you have AutoCAD version 2014 or later, you have to add the location of lisp modules (usually **c:\cadbestsoft**) to the "Trusted Locations" of AutoCAD options, to prevent asking for each lisp module during every loading session. In the AutoCAD tools menu, select **Options -> Files Tab -> Trusted Location,** click **Add...** and type in **c:\cadbestsoft** (or browse the installed folder) and press enter.
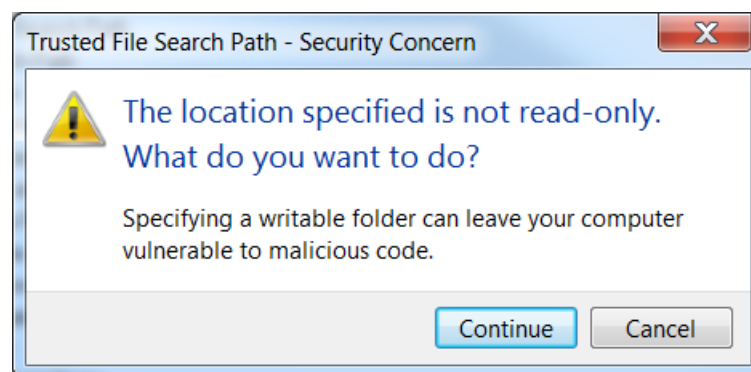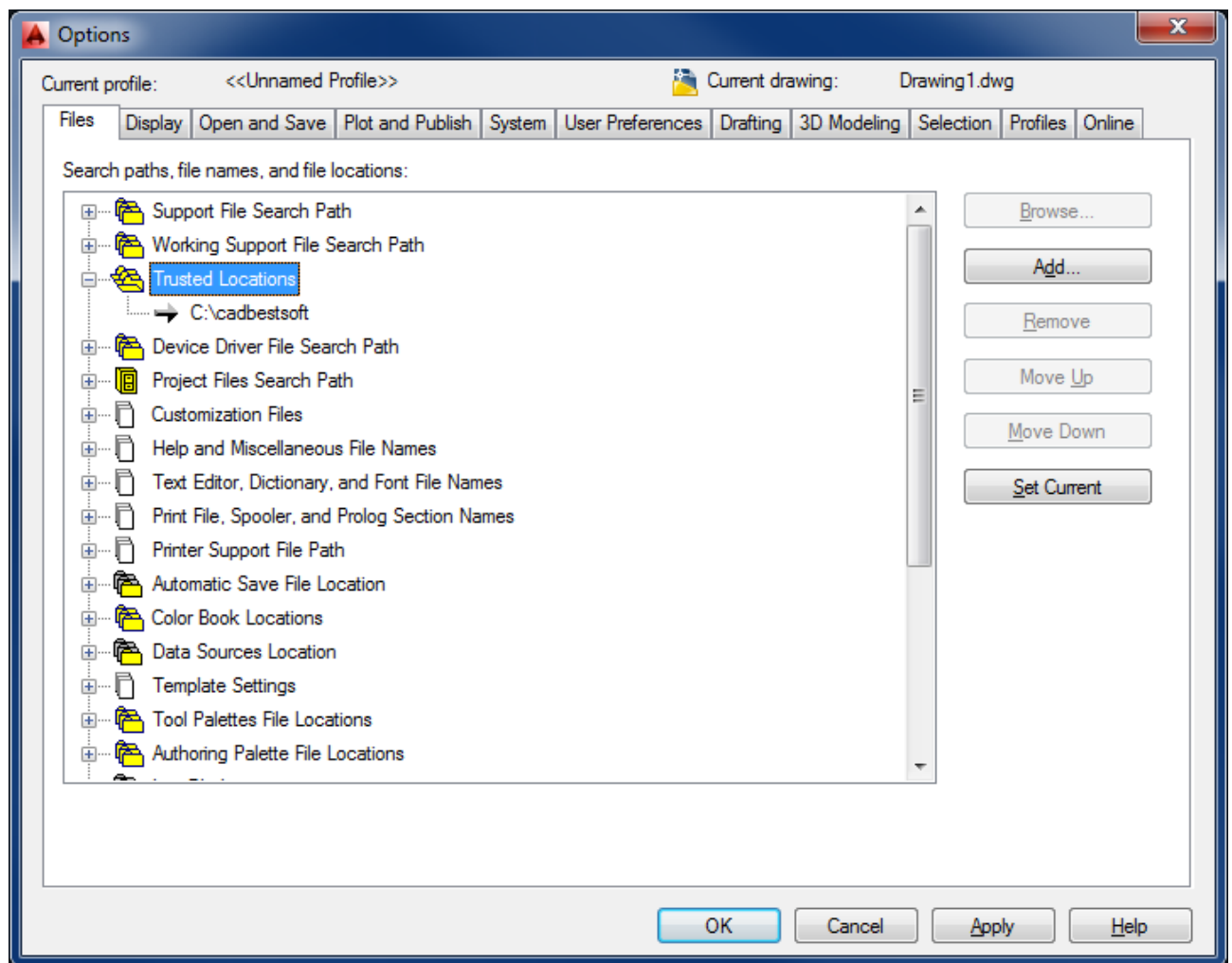
Then click **Continue**, to confirm that the location is not read-only. That isn't an issue, it's just a Autodesk's security warning. So you can continue your work as usual.

**4.**   *For more information or any troubleshooting don't hesitate to visit our website* http://cadbest.com *or mail us on* office@cadbest.com

# *Activation*

Activation is the process of verifying the serial number of a product, and licensing it to run on a specific computer. Activation cannot occur if the serial number is invalid, or if the computer is disconnected from the Internet. From each product menu in AutoCAD, or ζiTransform Help menu, you may choose About. If a product is not accessible due to ended trial period, you can register it from **Start Menu -> CAD BEST -> Register Products** shortcut or About.exe in your application directory.

**NOTE**: If your SurfMaster or zMeasure installation got broken, you can always repair it through the setup executable, or **Start Menu -> CAD BEST -> Uninstall CAD BEST software** and then select **Modify** option.
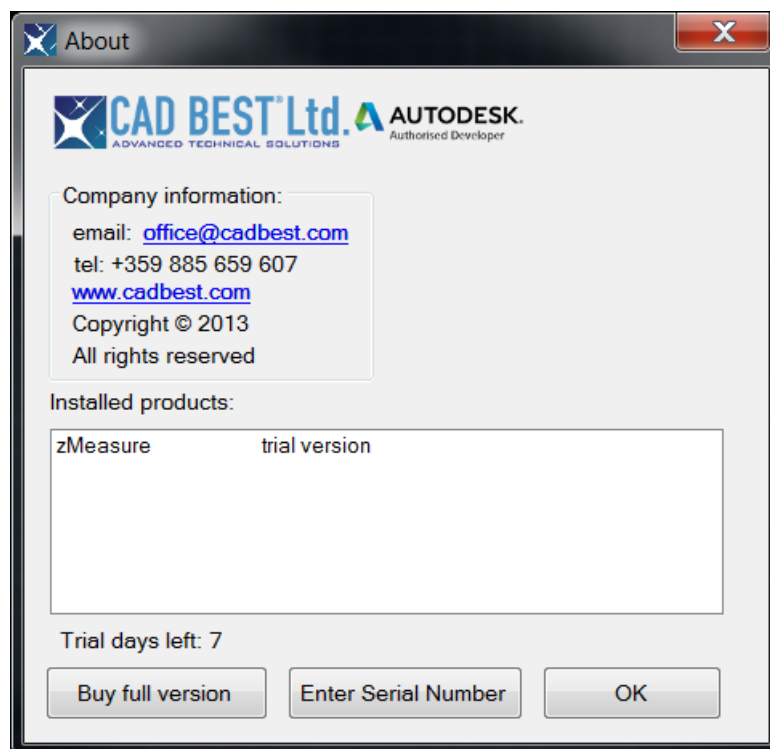


This window contains information about installed product and their license status.

You have two options:

- *Buy full version* – Go to web site and purchase the products
- *Enter Serial Number* – from this button you can enter valid serial number and activate the product
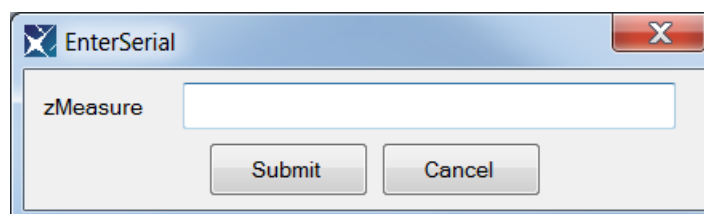
## Uninstall

To uninstall several products or the entire suite, it is recommended that you use the Uninstaller, which you can launch from the list of products on your computer (Start menu -> All Programs -> CAD BEST).
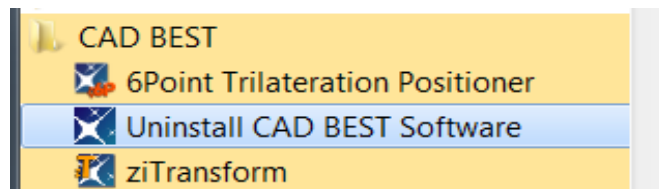


Alternatively:

Windows 7 and 8: Control Panel -> Programs and features

Windows XP: Control Panel -> Add or Remove Programs

**NOTE:** You can also uninstall the product manually by deleting the Installation folder with its contents but that is not recommended.

## Modify and repair

Launching setup executable after successful install, or the uninstaller, gives you also options for modify the software selection or repair the current installation. If trying the **modify option** and the setup executable is missing, you can download it again from our website. In the **Select Components** screen you can customize the current selection, to remove unnecessary components, or install additional ones.

**Repair option** gives you the opportunity to restore broken for some reason components of the products.

Again, these options require administrator privileges for the Windows user.